

White Paper Report

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Project Director: Robyn Peterson (director@artmuseum.org)

Institution: Yellowstone Art Museum

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White Paper

National Endowment for the Humanities



Sustaining Cultural Heritage Collections

Grant number: PF-50416-14

Report ID: 113050

Grantee Institution: Yellowstone Art Museum, Billings, Montana



Project Title: *Illuminating Art: LED Re-Lamping Project*

Project Director: Robyn G. Peterson, Executive Director

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Narrative Description of Project

The Yellowstone Art Museum's (YAM's) Sustaining Cultural Heritage Collections grant-funded project involved upgrades to the lighting systems in all of our galleries and public spaces, including 1) re-lamping with LEDs (over 500 lamps burning approximately 61 hours weekly), 2) replacement of failing track heads in two galleries, 3) installation of occupancy sensors in the one gallery that continued to lack this feature, and 4) upgrade of our environmental monitoring procedures. All aspects of this project took place in the YAM's 37,500-square-foot main museum building in downtown Billings, Montana.

Working within the parameters of the YAM's institutional strategic priorities, the project was designed to address parallel concerns: 1) respond to Conservation Assessment Program (CAP) survey recommendations and the staff's own awareness of needs within our preservation environment, and 2) continue to integrate environmental conservation systems, processes, and materials, following the success of green building features incorporated into our 2010 satellite facility, the Visible Vault.

Our Research in Advance of the Project

In addition to being informed by the success of the green features of the YAM's 2010 Visible Vault, the project stemmed from an encouraging small-scale foray into LED conversion, which occurred in 2012 when we reclaimed a new 920-square-foot gallery from an old collection storage vault and renovated it together with an adjacent 600-square-foot gallery. The various galleries within the YAM's main museum building are not metered separately, but the impact of bringing an additional 920-square-foot gallery online was not detectable in electricity usage levels or cost. We ascribed this to the conversion of the adjacent 600-square-foot gallery from tungsten halogen to LED, making the net effect of opening the new 920-square-foot gallery effectively zero.

Further, our experience in 2012 was that the quality of the light provided by the new LEDs in the two renovated galleries was superior. It dispelled staff concerns about color rendition and temperature, brightness, heat load, dimming capacity, and compatibility with occupancy sensors. Visitors commented on the pleasant "feel" of the new galleries without necessarily being able to pinpoint why. In a couple of cases, YAM staff made the admittedly leading comment that the gallery light feels more like daylight, to which all visitors immediately agreed. We had not experienced blotchy effects, beam spread, or distracting color shifts that required us to reformulate our "standard" gallery white paint color. Thus, the success of this initial foray into the use of LEDs in the YAM's exhibition galleries and our research led directly to the scope of the current project. Further, now three years on from the 2012 conversion, we can state that there has been no noticeable dimming or other change in light quality from the LEDs installed at that time.

Conducting extensive testing of LEDs relative to other lighting options was beyond the YAM's resources, but staff did a careful review of studies done by other museums or by other parties in museum contexts. This research eliminated any lingering doubts we may have had. Other institutions' studies indicated that the exponential advances in the technology made LEDs not only acceptable for museums and, specifically, for art preservation, but desirable. These studies had been thorough, addressing color rendering and visitors' psychological reactions to it, light intensity, coverage, equipment costs and longevity, elimination of residual UV/IR radiation, and long-term preservation effects.



Accomplishments

Did we achieve our goals? In a word, yes.

We continue to lead among our regional museum peers in the introduction of green building features, and nearly all lighting-related concerns raised in the CAP survey have now been addressed.

Recap of Desired Outcomes

The project outcomes relating to long-range institutional goals were:

- improve the preservation environment
- improve the YAM's green building / sustainability profile
- continue to address CAP survey recommendations
- contribute to the field by sharing positive results with museums who may still consider LEDs to be "experimental"

Desired practical outcomes were:

- reduce electricity usage (minimum 20% overall)
- reduce our environmental footprint
- improving our financial sustainability

Desired preservation goals were:

- reduce heat generated by the lighting system and the consequent desiccating effect that heat has on RH levels that are already difficult to maintain in a very dry climate
- reduce staff time spent maintaining lighting and, simultaneously, reduce the risk to art installed in the galleries when staff is attending to lighting system maintenance
- eliminate all UV/IR radiation originating from the lighting system
- improve and expand environmental monitoring procedures

In the six months since installation of the LED lamps was completed (two months since all dimmer modules were replaced), our experiences have borne out the researchers' reports regarding color quality, and further reduction of UV/IR radiation. In proximity to the new lamps, our equipment now detects zero UV/IR emitted. We cannot separately monitor the change in heat load due *exclusively* to the LEDs, nor factor out weather variables, but the heat emitted by the LEDs is so minimal (as something we physically feel) that we have to conclude that heat loads are also reduced and that the HVAC system, in turn, is struggling incrementally less to maintain a stable interior environment. We do suspect, however, that this element is not a huge factor in the drop we experienced in electricity usage.

Electricity usage is the most direct indicator of our success in achieving results (based on the museum's fiscal year calendar of 1 July – 30 June). Green indicates the data posted *after* the re-lamping:

Kilowatt-hour Usage

Month	2013-2014	2014-2015
November	37,840	39,840
December	47,440	41,760
January	46,080	48,720
February	51,040	35,360
March	40,880	38,800
April	39,520	28,000
May	38,560	29,840

Electricity Costs Per Day

Month	2013-2014	2014-2015
November	134.43	138.76
December	149.19	132.31
January	139.77	143.98
February	148.93	129.11
March	149.56	144.82
April	130.02	111.03
May	130.22	98.65

It was through this process that we discovered, upon receiving the January electricity bill (which appeared to reflect no benefit whatsoever from the lamp conversion) that an actual reading is taken by the power company only every other month, alternating with an estimated reading. For the four-month period February-May, electricity usage declined 22.4% compared to the same period in 2014. This four-month period includes two actual readings and two estimates. One of our desired outcomes, noted above, was a minimum 20% reduction in overall electrical usage, and this was achieved. Thanks to rising unit costs, the average monetary savings was less good, a 13.4% drop in the average monthly bill. As the first year of operation progresses, we expect to see further reductions as the power company estimates based on prior year usage increasingly factor out. We had anticipated an annual savings of about \$7,600 and our new calculations are closer to \$6,400, which is still a significant savings in the YAM's modest operating budget.

Enhanced Environmental Monitoring

The final step of our re-lamping project had been to expand the array of environmental monitoring data points in order to collect new information on the consistency of light levels, bulb life, lamp behavior when used on dimming settings, and visitor perception of the ambience created by the new lamps. Year-round atmospheric dryness and dramatic temperature swings are standing challenges in south-central Montana. It is not uncommon for the outdoor temperature to swing as much as 70 or 80 degrees or more in a single 24-hour period. The reduced heat load compared to the tungsten halogen lamps that the LEDs replaced was a much-desired outcome of this project, one that we anticipated would improve our ability to achieve both stable temperature and RH targets. This heat load issue, which was a side effect of the halogens, is presumed to have had an additional negative impact on our efforts to maintain a *stable* environment, with heat ramping up all day and winding down all night both indoors and out. Thus, when we examine the reduction in electricity usage, we must assume that a proportion of that is due to the air-handling system having to work less hard to counteract

the variable heat loads at ceiling and track light level; we are not equipped to monitor this separately.

Additional projected outcomes included reduction of the time necessary to replace lamps, which is already evident. In the six months since the lamps were all changed, we have not had to replace a single one of the over 500 we have. Prior to the conversion, changing at least a couple of bulbs occurred weekly. Further, our improved systems of environmental monitoring are gradually giving us solid evidence of other benefits, including a reduction in measurable light levels where there is no *apparent* loss of brightness. Average foot-candle readings in the YAM's permanent collection galleries (the first spaces to be converted to the LEDs) went from 16.32 in early December 2014 to 13.58 in late January, a 17% reduction. We are not able to provide data for the affective component, i.e., sensing that, in spite of this reduction, there is no perceptible difference in light intensity.

We have supplemented our prior monitoring data points by 1) recording dates that the new lamps were installed in each location, 2) collecting light level and UV/IR readings from more locations, 3) pinpointing data collection locations more closely to ensure better apples-to-apples comparisons, and 4) correlating interior environmental readings with weather statistics. These new data points supplement the prior array of temperature / RH information and UV readings we have collected during many years of using the halogens. Because our galleries are on occupancy sensors, we have yet to develop a practical way to track estimated burn hours for individual lamps.

Ideally, it will be several years before we are able to test manufacturers' claims of the 50,000-hour bulb life, but our monitoring techniques now enable us to note when we begin to experience changes in light color, light intensity, or dimming capacity. Should failure occur after the individuals involved in the project have left the YAM's employ, subsequent staff should be able to continue to monitor the new lamps' effectiveness, at a minimum, on the level of lamp life.

An unanticipated delay in the project arose when we discovered that we had not been aware of all of the dimmer panel locations when the project was originally cost-estimated. Further, all of the dimmer panels we had were not identical. The problem was dealt with by our electrical contractor, but it added \$5,454 in costs and close to four months to the project schedule as research was done, parts ordered, and on-site work integrated into the contractor's schedule. We estimate that this increases our payoff period by an estimated ten months.

A completely unanticipated positive outcome has been an uptick in retail sales now that we have the ability to wash that area in more light, and full spectrum light at that. Our small retail space is in the entry hall, which—as an area that occasionally is used to exhibit sculpture—was included among the galleries that were part of the re-lamping project.



Audiences

From a public perspective, this was the kind of project that introduced improvements largely unnoticed by the public: operational efficiency, lowered costs, lighter carbon footprint, and improvements to our ability to maintain the preservation environment. As noted above, visitors who are on site frequently or trustees who knew the LED re-lamping project was under way were most apt to notice a difference in the light quality, and comments were positive, some

enthusiastically so. This project did not change the kind of audience we have or its scope or size. We did inform our membership of the project through a notice in our quarterly newsletter about the impending lamp changeover and the fact that it was an NEH-supported undertaking. A handful of members responded specifically to this notice, praising us for taking the step.



art auction
yam
47

Art Auction 47
Opening reception Thursday, January 22, 2015
5:30 p.m.

Save the date for the **Art Auction 47** event
Saturday, March 7, 2015

We gratefully thank our title sponsor:
Oakland Companies

Noon tours of Art Auction 47!

Join us Wednesday at noon, February 11 or 25, 2015, for a tour of the annual Art Auction exhibition. Learn more about the art and artists who help make this event our largest fundraiser of the year. No registration required. Free to members or with paid museum admission.

Boundless Visions
Stop in to see selections from our permanent collection in our ongoing exhibition *Boundless Visions*, located in the Scott and Murdock galleries.

Boundless Visions is supported by David Orser and Ossie Abrams.

Another Shade of Green

We're converting to LEDs! Watch our galleries transform in time for the new year as we replace our heavy energy-using bulbs with conservator-approved LEDs. We anticipate a dramatic drop in electricity usage and improved gallery lighting. This project is made possible by a grant from the Sustaining Cultural Heritage program of the National Endowment for the Humanities.



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Evaluation

On-site environmental data collection and comparing electric company usage statistics have been our forms of project evaluation. The enhanced data collection protocol we now have will continue indefinitely, and we are strongly committed to gathering more (and more reliable) data as we consider further refinements to our preservation environment. Additional levels of data collection will be implemented as we develop or learn of methods that promise meaningful results (for example, measuring lamp heat loads).

The long-term impact will be that the project has bolstered our already-strong commitment to our environmental policy and to improving our art-preservation environment.

Lessons Learned

In the category more of “lessons re-learned,” we were reminded that even a project of apparent simplicity—replacing light bulbs—can deliver unanticipated delays and outcomes. In our case, the discovery of additional dimmer modules that required replacement to ensure compatibility was a lesson learned about maintaining familiarity with our own site, as well as the value of retaining architectural drawings and keeping them updated as system changes are made over time. This element delayed full completion of the hardware installation side of the project by four months and increased total projects costs by \$5,454. Surprises can be positive as well, and in this category, we count the beneficial impact of pleasant and adequate lighting in our retail area.

In the wake of this success, our commitment to careful introduction of green building elements will continue, weighing the demands of collection preservation and our own very limited operational resources with the benefits to increasingly “going green.”